



Office of ENERGY EFFICIENCY
& RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

2022 SETO PEER REVIEW



Soft Costs Balance of Systems

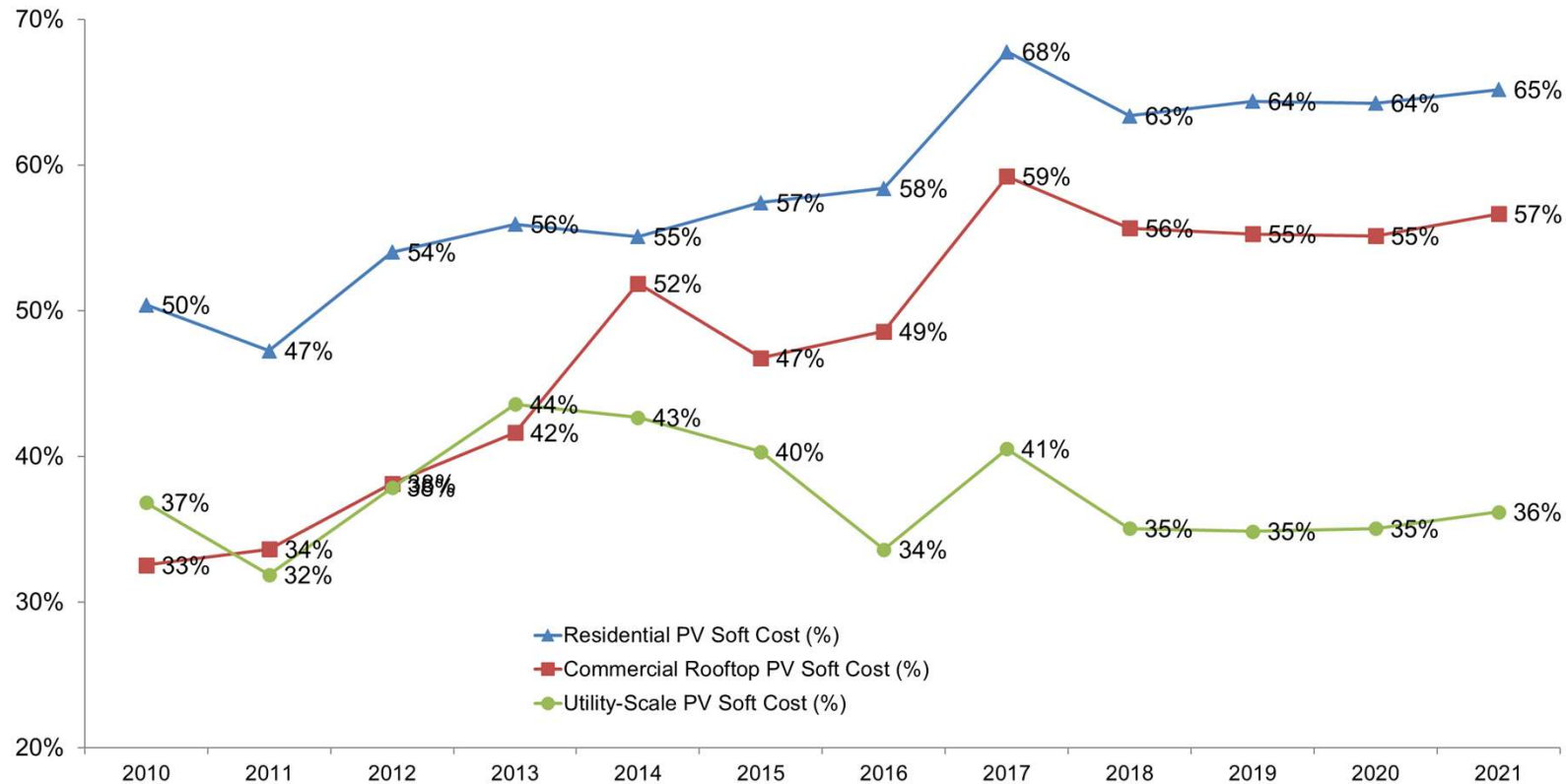
Michele Boyd

Program Manager, Strategic Analysis and Institutional Support

Nicole Steele

Program Manager, Workforce and Equitable Access

Solar Soft Costs (as Percentage of Total Cost)

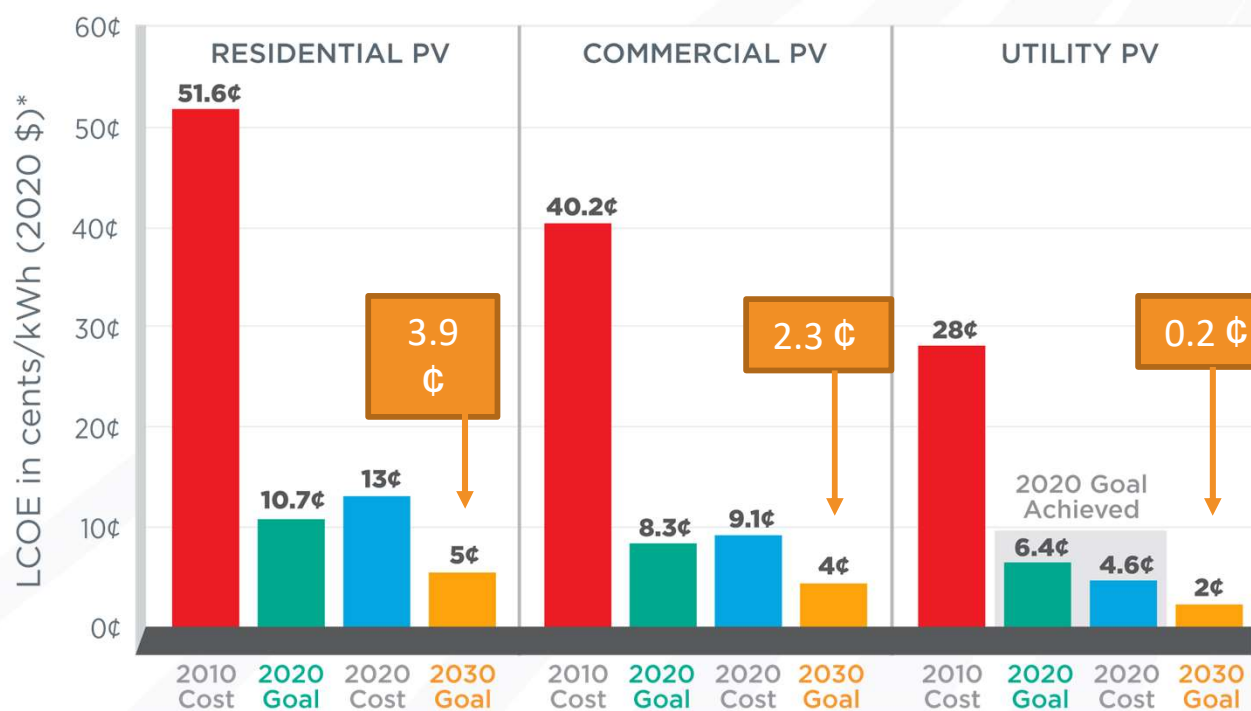


Source: National Renewable Energy Laboratory "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2021."

Progress and Goals: 2030 Photovoltaics Goals

Reducing soft costs is key to reaching SETO's 2030 cost goals.

Solar Energy Technology Office Progress and Goals for Photovoltaics (PV)



Potential reductions from soft costs

SETO Multi-year Program Plan Goals (2025)

Lowering the cost of Electricity from PV

- LCOE less than \$0.10/kWh for residential PV and \$0.08/kWh for commercial PV

Growing the U.S. solar industry

- Diverse solar workforce meets the needs of the industry and of disadvantaged communities and grows to employ at least 300,000 workers

Reducing the life cycle impacts of solar energy

- Environmental impact of PV technology, prioritized based on a life cycle impacts



Opening new markets

- 1 GWAC of PV installed in 2025 is combined with another use, such as agriculture or building structures

Ensuring that solar energy benefits all

- 100% of U.S. energy consumers can choose residential solar or community solar that does not increase their electricity cost

Soft Costs Topic Areas

Permitting, Inspection, and Interconnection

- Improve permitting and inspection for rooftop solar, as well as interconnection of solar to the distribution and transmission grids

Solar Siting and the Environment

- Overcome barriers to siting large-scale solar, including understanding solar-environmental interactions

Data, Analysis, and Tools

- Collect and develop data, analysis, models, and user tools to help solar stakeholders overcome a range of barriers to solar deployment

Solar Energy Access

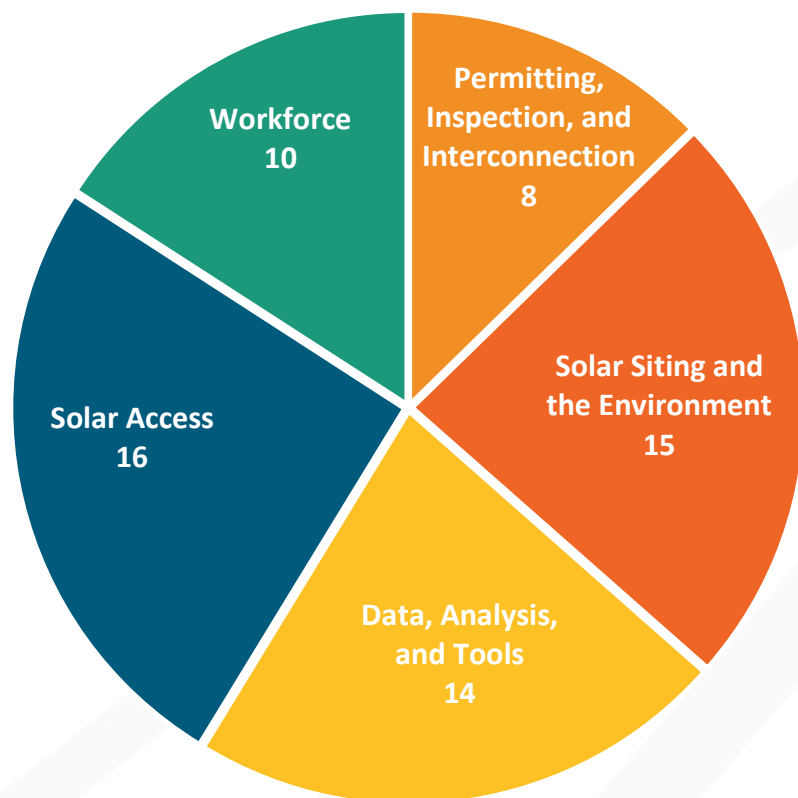
- Increase access to the benefits of solar energy, especially in underserved communities

Workforce

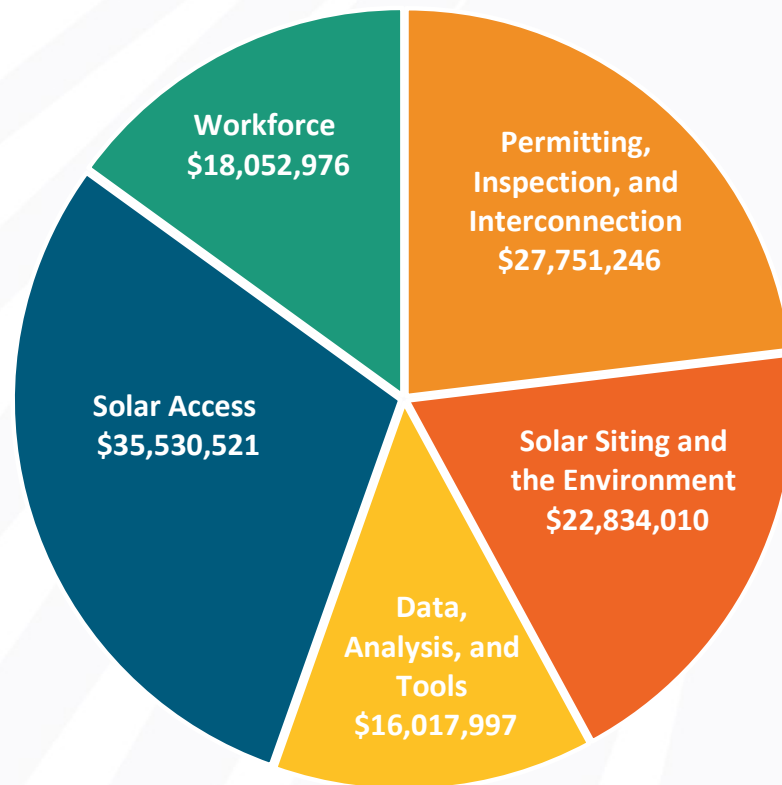
- Ensure a diverse, well-trained, and well-paid solar energy workforce that can meet the needs of the industry and of disadvantaged communities

Soft Costs Portfolio - Award Breakdown

Soft Costs Projects (#) by Topic Area



Soft Costs Funding (\$) by Topic Area



Strategic Analysis and Institutional Support Team



Michele
Boyd



Christopher
Anderson



Shay
Banton



Juan
Botero



Krysta
Dummit



Zachary
Eldredge



Rebecca
Glaser



Andrew
Graves



Tiffany
Jones



Caroline
McGregor



Tomiwa
Olufolabi



Ammar
Qusaibaty



Abigail
Randall



Daniel
Sodano



Diana Sun

Workforce and Equitable Access Team



Nicole Steele



Anna Balzer



Benjamin
Burch



Ariel
Drehobl



Jamal
Ferguson



Andrew
Graves



Tomiwa
Olufolabi



Chani Vines



Sarah
Wilder



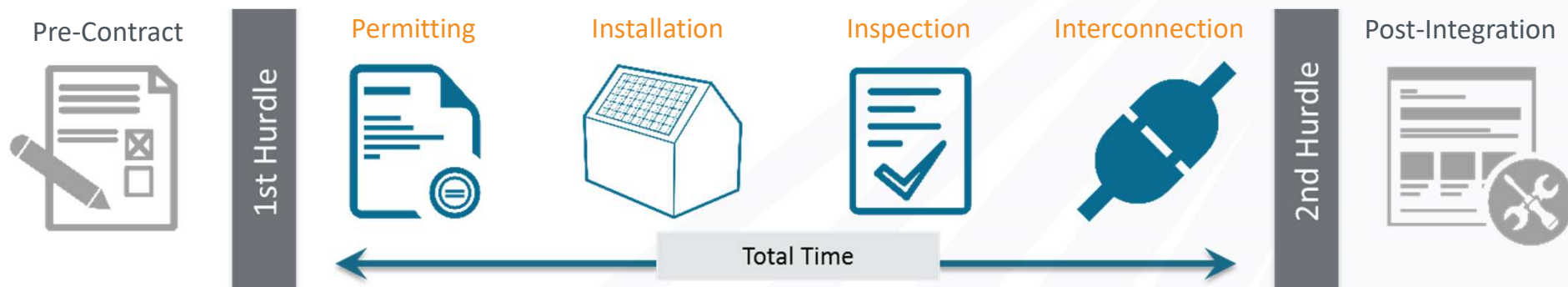
Diana Sun

Extensive Stakeholder Engagement

- **20 Stakeholder workshops**
 - Community Solar (13)
 - Interconnection (2)
 - Solar-Wildlife Interactions (2)
 - Solar Workforce (4)
 - Energy resilience (with SI team)
 - PV End of Life (with PV team)
- **2 DOE Co-sponsorship of Events**
 - AWWI Solar-Wildlife Symposium
 - Behavior Energy and Climate Change conference
 - NCSP Annual Summit
- **External Event Presentations**
 - Webinars
 - Conferences (virtual)
- **4 Requests for Information**
 - Equitable Access to Community Solar
 - PV End-of-Life
 - Solar-Wildlife Interactions
 - Solar Workforce Development
- **Federal agency collaboration**
 - HHS, HUD, USDA, DOL, USFWS
 - OMB – Pilot Justice40 program
 - USDA-DOE Workshop on Agrivoltaics (2)
- **State collaboration**
 - State Energy Offices
 - State Wildlife Agencies

Permitting, Inspection, and Interconnection (PII)

Time Wasted is Costly to Consumers and Market



If every system installed is delayed unnecessarily by just one day, the cost to the market will be approximately

\$4.7M/day*

*Lost revenue from electricity sales. Calculations based on 2020 deployment level, assuming historic average irradiance of electricity generation a day and at weighted average retail price of \$0.06 per kWh.

PI Strategy – Rooftop Residential Solar

Goal: Reduce PI timelines and soft costs; streamline and improve PI processes in order to accelerate solar deployment across the U.S.

Priorities:

- Broad geographic reach, while advancing equity and diversity goals
- Balanced focus between integrating new technologies, while meeting baseline standards
- Emphasize data collection and analysis that demonstrates impact, particularly for PI timelines and costs



Solar Automated Permitting Process (SolarAPP+)


A web-based tool for permitting residential PV (and storage) systems at no cost to local jurisdictions

- Evaluate applications for **safety and code compliance**.
- Enable **standardization** of permitting processes.
- Deliver **automated**, instant plan review and **permit approval**
- Provide a clear **inspection checklist** to streamline inspection processes
- **Integrate with existing software** platform(s)
- **Incorporate energy storage** and expand to other market segments.
- Focused **TA for underserved communities**

Create an Application

Search Applications

Schedule an Inspection



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Residential Solar Permit with SolarApp

1 Step 1

2 Project Information

3 Step 3

4 Review

5 Pay Fees

6

Step 3: Step 3 > Support Documentation

* Indicates a required field.

Attachment

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are disallowed file types to upload.

This application type requires you to submit the following types of documents. Subject to the collected information, you may be required to submit additional documents prior to approval.
SolarApp Approval, SolarApp Spec Sheets

Name	Type	Size	Latest Update	Action
SolarApp Approval.pdf	SolarApp Approval	7.05 MB	03/15/2021	Actions ▼
Solar App Spec Sheets.pdf	SolarApp Spec Sheets	3.47 MB	03/15/2021	Actions ▼

Select from Account

Add

Continue Application »

Save and resume later

➤ Results from a recent analysis of 5 pilot communities found that SolarAPP+ sped up the PI timeline by 12 days and saved more than 2,300 hours in local staff time.

SolSmart



SolSmart is a national recognition and technical assistance program for local governments to streamline processes and make it easier for residents and businesses to go solar in their community.

Designation

- SolSmart uses objective criteria to designate communities that have successfully met these goals.
- **Over 400 cities and counties** have received designations of SolSmart Gold, Silver, and Bronze



165

Gold Designees



109

Silver Designees



150

Bronze Designees

424

Designees
(as of January 2022)

Technical Assistance

- Program participants are eligible for **technical assistance** from a team of national experts to help achieve the SolSmart designation.

Next Steps for SolSmart

- This spring, SETO plans to announce \$10M in awards to continue the program another 5 years, with a focus on equity goals and other new priorities.

SolSmart is led by:



Interconnection Portfolio Overview



Grid Capacity



Application



Impact Analysis



Agreements



Construction &
Installation



Commissioning

2022 SETO Peer Review

Interconnection Portfolio Overview



Grid Capacity



Application

Barriers to Creating
Hosting Capacity Maps

User Confidence
In Hosting Capacity Maps

Stakeholder Input



Impact Analysis



Agreements



Construction & Installation



Commissioning

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Interconnection Portfolio Overview



Grid Capacity

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Grid Capacity

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Application



Impact Analysis

PV+Storage
Codes & Standards

PV+Storage
Interconnection Process

Consensus
Recommendations



Agreements



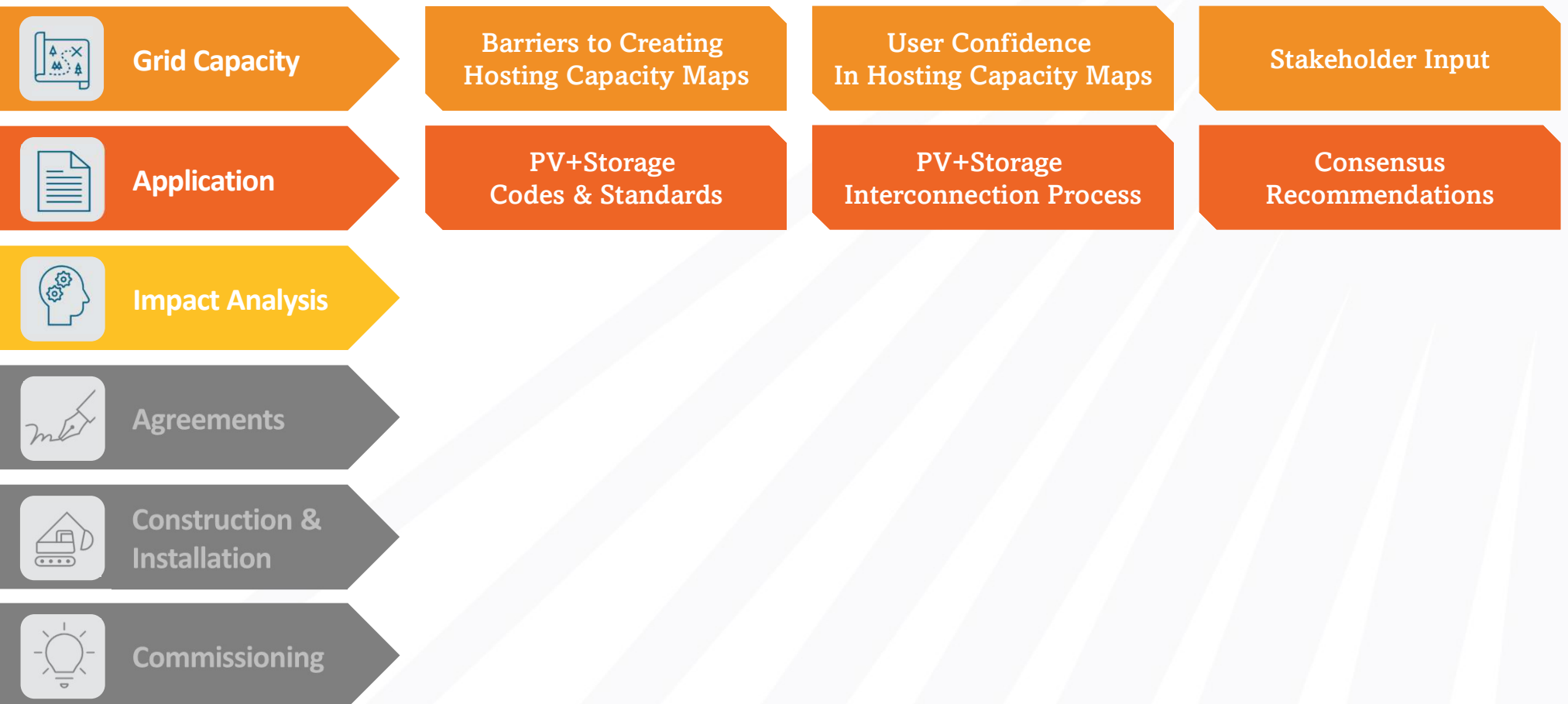
Construction &
Installation



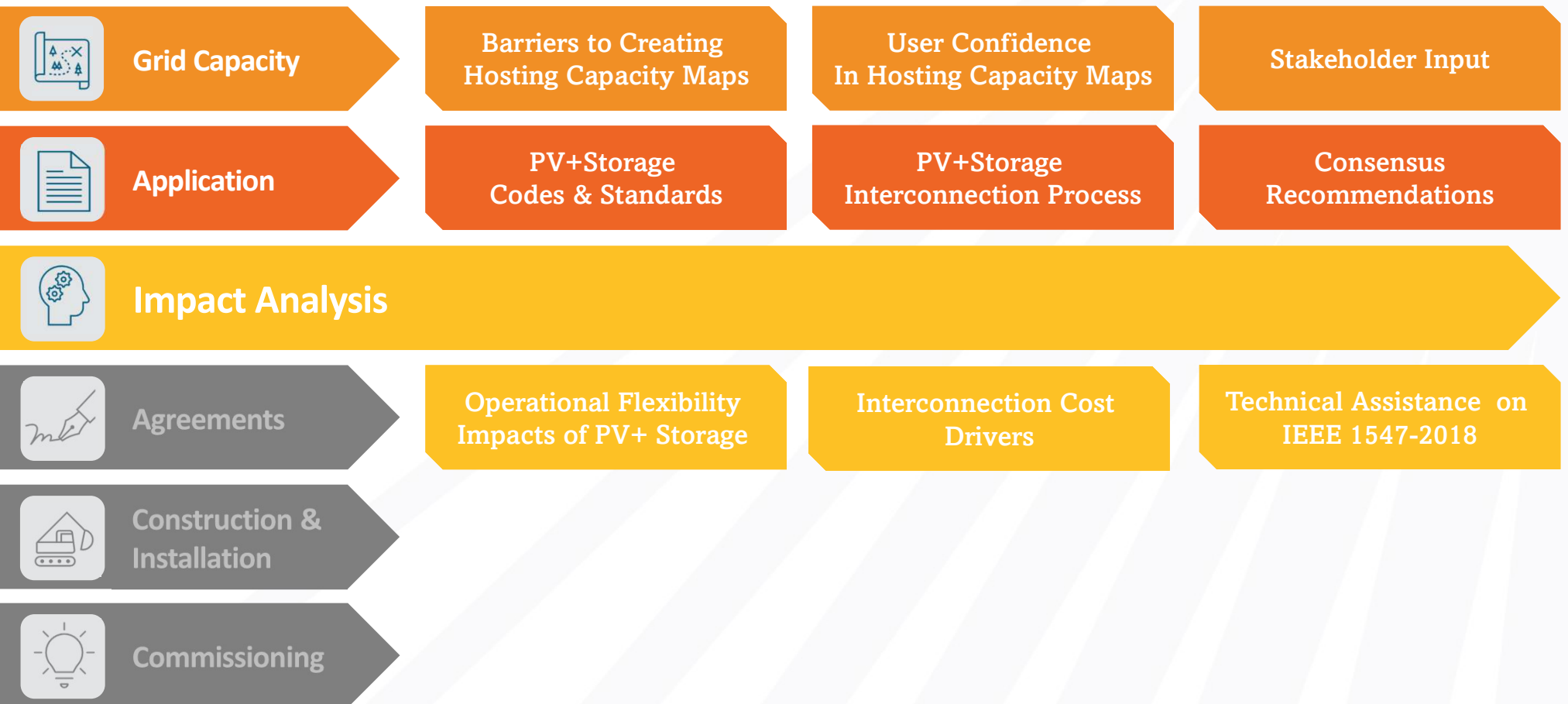
Commissioning

2022 SETO Peer Review

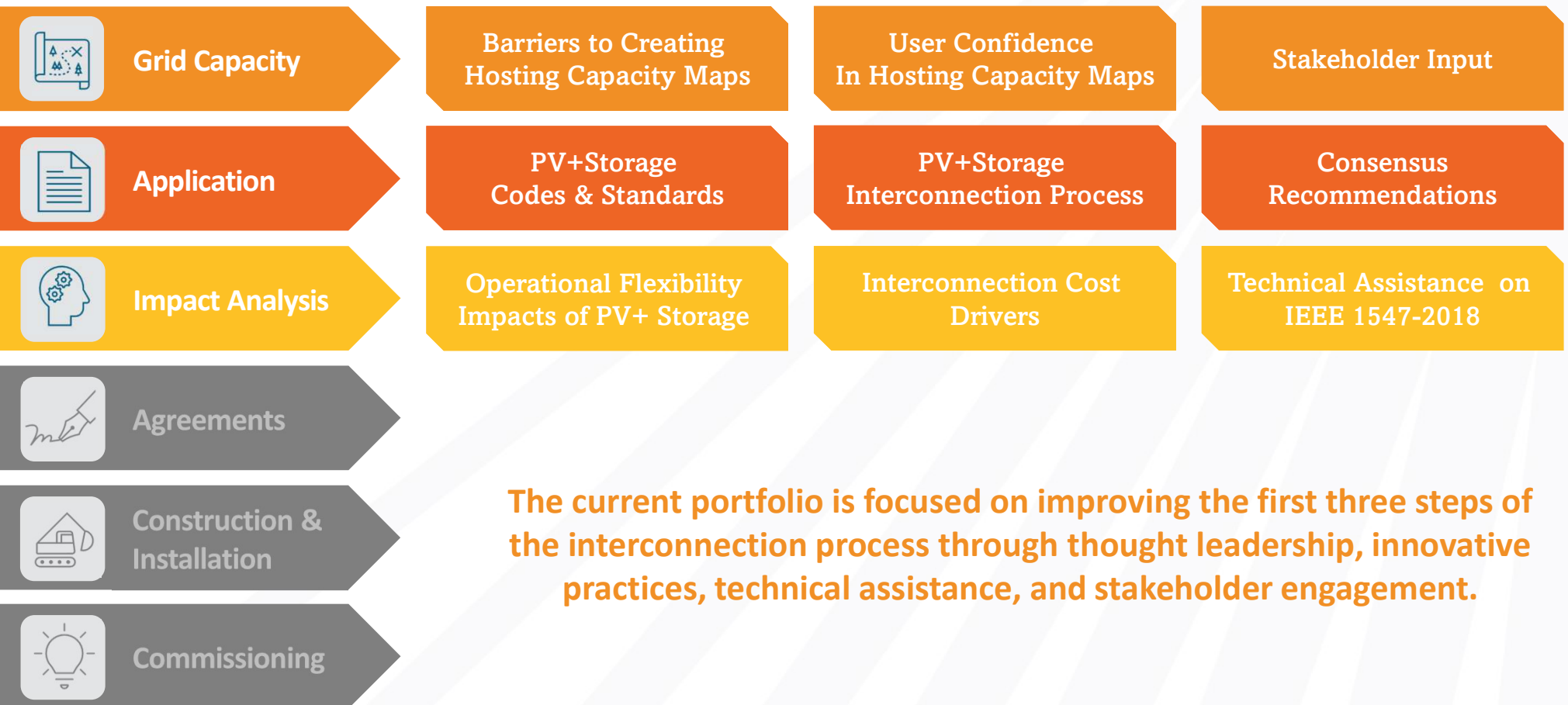
Interconnection Portfolio Overview



Interconnection Portfolio Overview



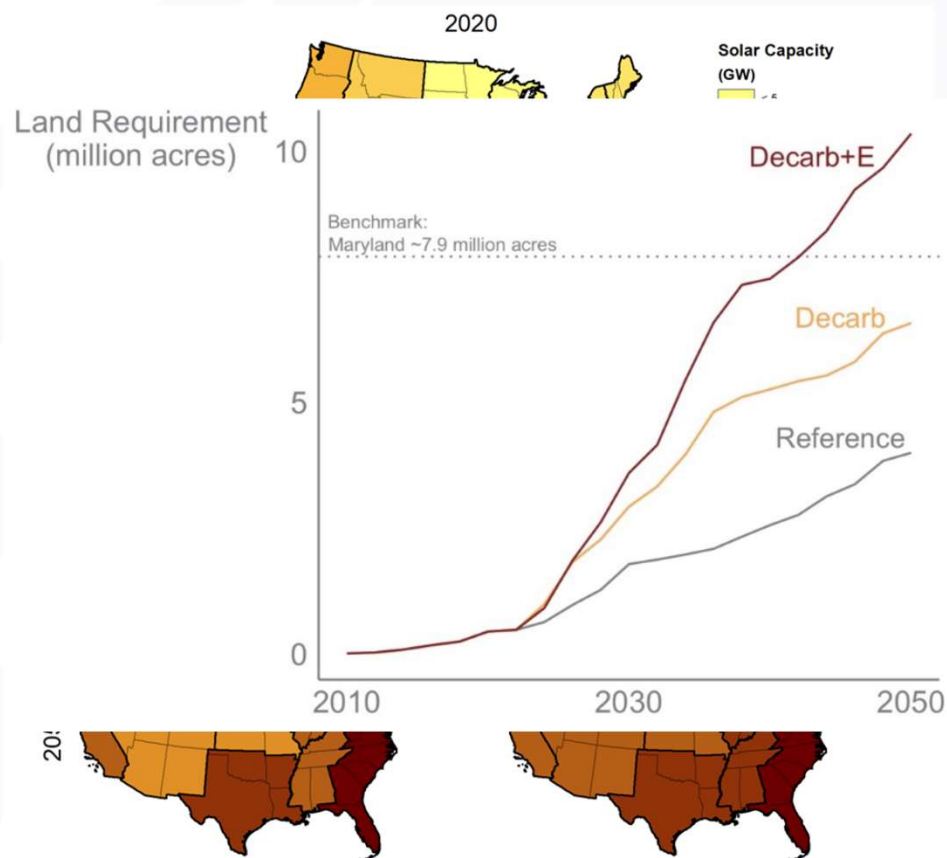
Interconnection Portfolio Overview



Solar Siting and the Environment

Solar Futures Study: Lots of Solar to Site

- In *SFS* scenarios, every Census region has more solar in 2035 than the highest regions do today
- Lots of capacity deployed in Georgia, Florida, Texas -- these regions are less prepared than more mature markets (CA, AZ).
- Ground-mounted solar is projected to require about **5.7 million acres** by 2035 (0.3%), increasing to as much as **10 million acres** in 2050 (0.5%)



Solar Friction in Local Communities

The New York Times

He Set Up a Big Solar Farm. His Neighbors Hated It.


A push toward renewable energy is facing resistance in rural areas where conspicuous panels are affecting vistas and squeezing small farmers.

Locals Worry Wind and Solar Will Gobble Up Forests and Farms


Voices Across America

Opinion: Solar energy's luster dims in rural southern Ohio

Solar Siting Research Framework

- 
- Land use modeling and analysis
 - Mapping
 - Siting costs/timeline quantification

Foundational Data and Analysis

- 
- Economic impacts (jobs, revenue)
 - Stakeholder perceptions/knowledge flows
 - Community-driven siting

Social Benefits and Costs



Innovative Siting Solutions

- Floating solar
- Agrivoltaics (pollinators, grazing, and crops)
- Solar on contaminated lands and mine lands



Environmental Benefits and Costs

- Wildlife
- Native vegetation
- Water and soil quality
- PV End of life
- Carbon emissions

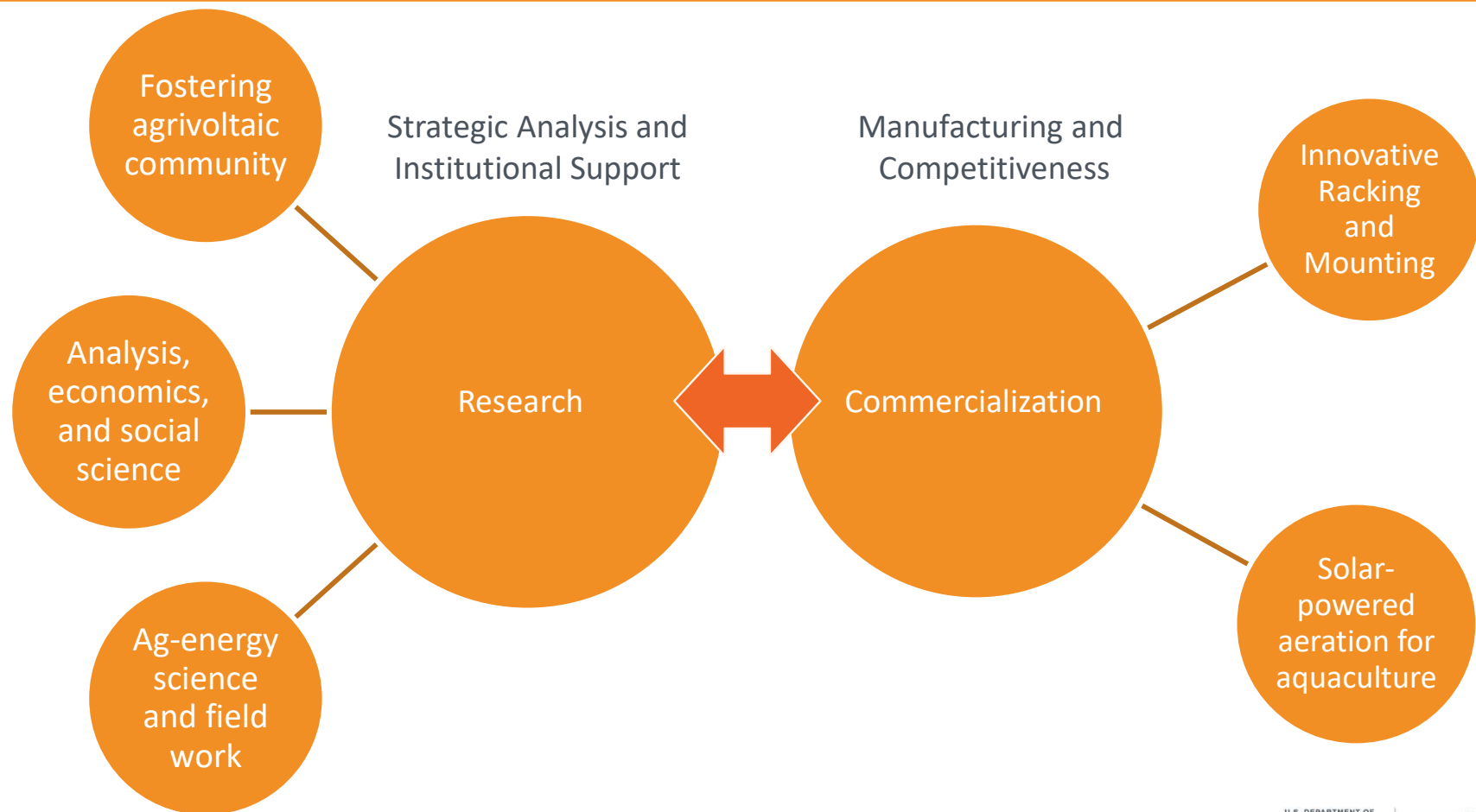
Spotlight #1: Agrivoltaics = Agriculture + Photovoltaics

Can solar be combined on the same land with agriculture to the benefit of both agriculture and solar energy?

- Agriculture is defined as crops, livestock and/or pollinator habitat
- Potential benefits for farmers:
 - Provide diversified revenue
 - Reduce irrigation water needs
 - Improve crop yield, especially in dry areas
 - Improve resistance to extreme weather, such as droughts
- Potential benefits for solar industry:
 - Reduce land-use competition
 - Improve panel performance
 - Lower solar O&M costs



SETO Research and Commercialization Activities in Agrivoltaics



NREL InSPIRE 3.0

InSPIRE 3.0 provides research and thought leadership to enable the expansion of agrivoltaics

Field Research

- Evaluate crop performance and irrigation savings in different geographies, configurations, and crops
- Study agrivoltaics using bifacial panels
- Evaluate ecosystem services, including pollinator diversity/abundance, wildlife habitat, soil health
- Develop solar-sheep grazing guidelines

Foundational Analysis and Data

- Develop research protocols and research roadmap
- Conduct economic analysis of scaling to multi-MW installations
- Track growth of the sector and trends/patterns
- Build on InSPIRE data portal and website

Thought leadership

- Grow ASTRO network
- Host a conference on agrivoltaics
- Assist with interagency collaboration (USDA, DOI)



InSPIRE research team on-site in Minnesota

Other SETO Agrivoltaics Work (FY20 FOA)



National Center for Appropriate Technologies

- Building an AgriSolar Clearinghouse to connect practitioners with resources and each other



Silicon Ranch

- Exploring solar combined with rotational cattle grazing in Georgia



University of Illinois – Chicago

- Scaling pollinator-friendly solar ground cover to large (10MW+) projects



University of Massachusetts – Amherst

- Studying agrivoltaic farm performance and economics across the state on multiple crop types

Each project is 3 years; total \$7M in funding

Spotlight #2: Avian-Solar Interactions

- Avian interactions with utility-scale solar facilities (PV and CSP) are **not well-understood** → **delays** in project approvals and/or **increased costs** for monitoring and mitigation
- Better understanding of the **types** and **magnitude** of avian-solar interactions is needed to:
 - **Minimize negative impacts** on avian species and populations; **maximize positive impacts** (e.g., ecosystem services)
 - **Improve solar facility siting**
 - **Support well-informed agency decisions** (permitting, mitigation, and conservation requirements)
 - **Minimize soft costs** due to permitting delays and monitoring/mitigation
- **Widely shared data, methods, and technologies are needed to better understand and mitigate impacts**
 - Biological studies to determine avian impacts at solar facilities are **expensive, time-consuming and often not conclusive**

Current SETO Avian Work (FY19 FOA)



Argonne National Lab

- Developing an AI-based edge computing camera system which identifies, tracks, and classifies avian activities at solar sites



Electric Power Research Institute

- Developing drone and LIDAR technology which can be used to track and monitor avian activity at solar sites automatically

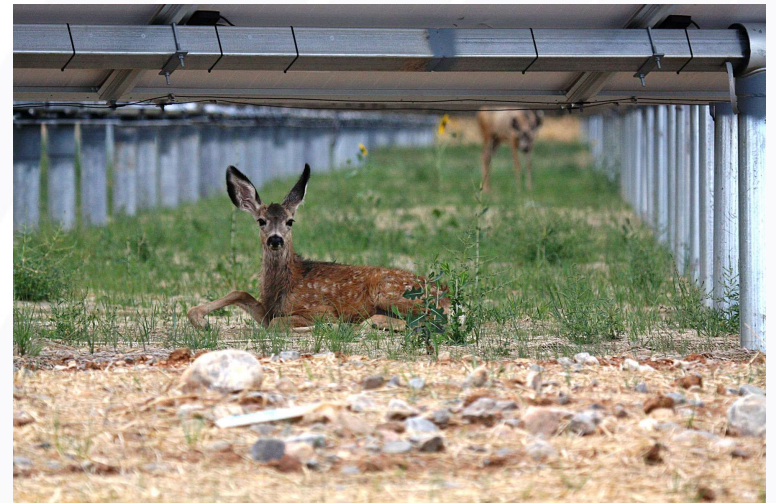


University of California – Los Angeles

- Developing genetic analysis techniques to understand species and population impacts based on remains found at solar sites

Beyond Birds

- As solar has expanded, questions have arisen about solar interactions with other taxa and species (e.g., ungulates, gopher tortoises).
- In 2021, SETO:
 - Conducted stakeholder workshops (Summer/Fall 2021)
 - Released RFI (Fall 2021.) Summary [here](#).
 - Co-sponsored AWWI (now REWI) “Symposium on Solar and Wildlife/Natural Resources” (December 2021), 600 attendees



Data, Analysis, and Tools

Data, Models, and Analysis Areas of Focus

Data Resources & Management

- Open Energy Data Initiative (big data lakes)
- O&M field data in climate zones
- Data standards and multi-DER evaluation for resilience planning

Tech Optimization / Adoption Models

- Technology Integration cost and optimization (REopt, SAM)
- Simulation tools for scheduling solar + storage power plants
- Customer adoption model (dGen)

Solar Market Analysis

- National solar market data collection and trends analysis
- Southeast solar + storage planning
- EE + PV + storage metrics and analytics

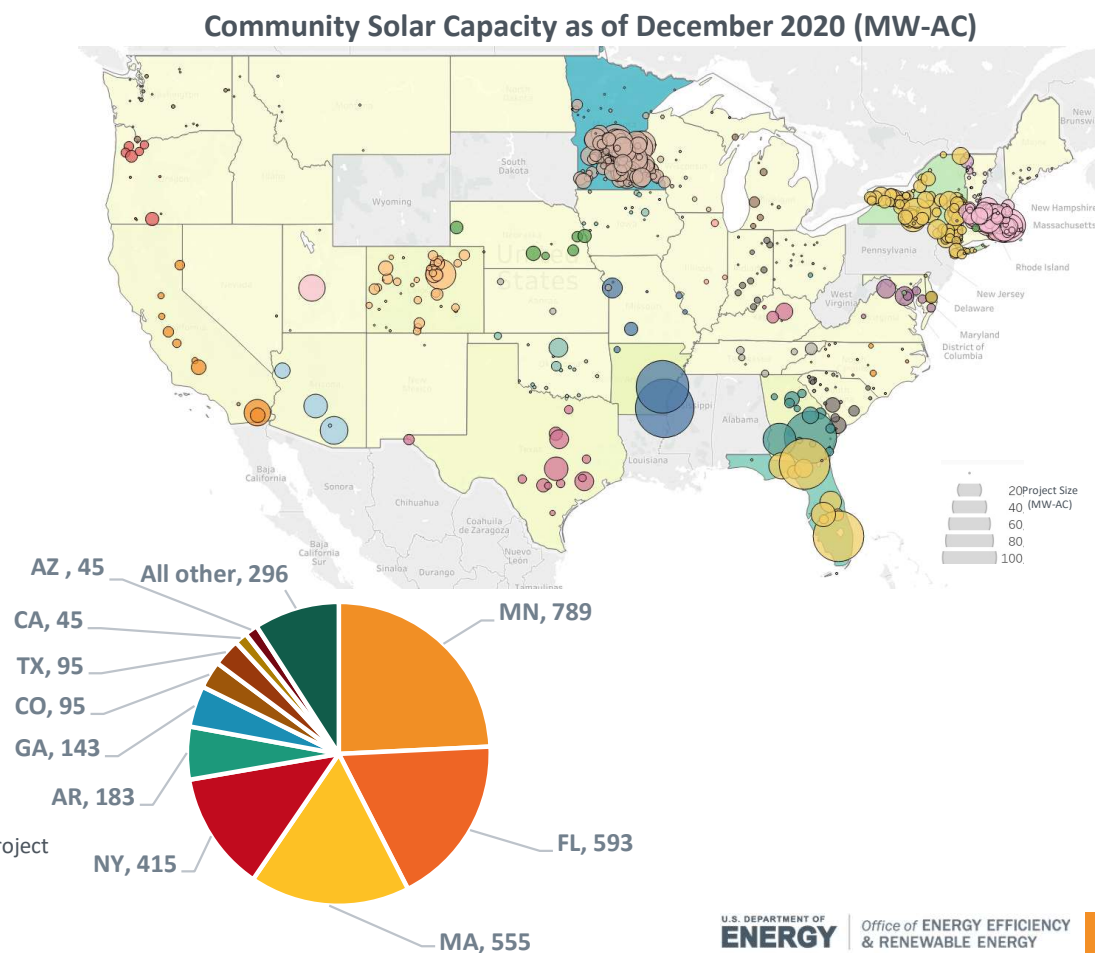
Social Science Analysis

- Co-adoption of solar + storage, EVs and EE
- Knowledge flow of solar energy
- Solar cybersecurity learning via public-private institutional engagements

Equitable Access to Solar

Community Solar Market is Growing but Remains Highly Segmented

- >5.02 GW-AC, 1,900 projects located in 39 states and Washington, D.C.
- Cumulative community solar capacity has grown by about 121% year over year since 2010, in other words, capacity has more than doubled on average year over year
- About 1.6 GW came online in 2021 alone
- >90% of cumulative capacity is located in 10 states



Source: Heeter, Jenny; Xu, Kaifeng; Chan, Gabriel (2021): Sharing the Sun Community Solar Project Data (Dec 2020, Revision). National Renewable Energy Laboratory.

<https://data.nrel.gov/submissions/167>

National Community Solar Partnership Overview

Increased Stakeholder Engagement

JULY: 55 responses to Equitable Community Solar RFI

JULY-AUGUST: 30 states participated in a series of 3 State Convenings

SEPTEMBER: 75 organizations participated in a series of 2 Community-Focused Organization Convenings

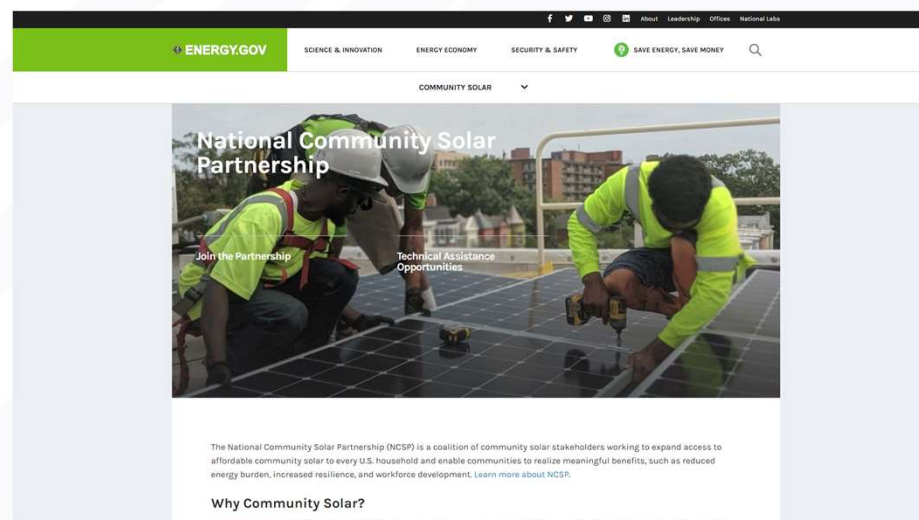
AUGUST – NOVEMBER: Over 50 conversations with lenders and philanthropy partners

NOVEMBER: 15 CEO/business leaders participated in Business Leader Roundtable

DECEMBER: Over 40 participants in Credit Ready Solar Lender Kickoff; 21 conversations with State Energy Offices

JANUARY: Over 630 participants in NCSP Annual Summit; 20 participants in Credit Ready Solar Philanthropy Kickoff

Elevating Program Recognition



>800
PARTNERS



>500
ORGANIZATIONS



49
STATES

Barriers to Equitable Community Solar Deployment

Policy & Program Design

- Lack of enabling legislation
- Program limits/caps to deployment
- Restrictions set by utilities

Financing & Funding

- Monetizing tax credits
- Lack of pre-development capital
- Perceived risk
- Difficult to find consistent affordable debt

Capacity

- Limited staff time and expertise
- Lack of training for long-term project operation & maintenance
- Challenge of small project size

Customer Subscriptions

- Verifying low- to moderate-income households
- Connecting customers with subscriptions
- Streamlining process

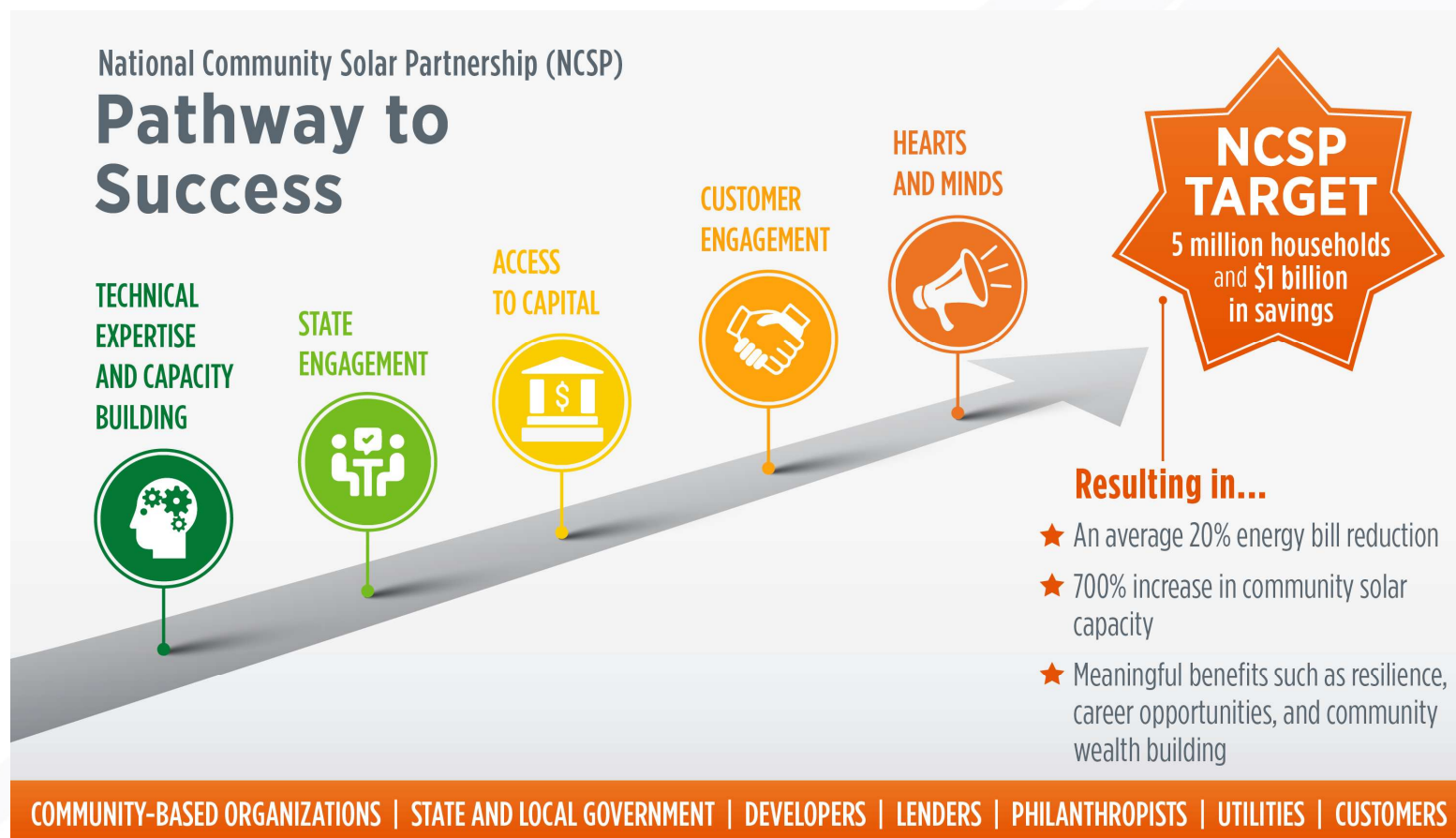
Messaging & Communication

- Standardizing language & messaging
- Consumer protections
- Recognizing successful projects and programs

Siting & Interconnection

- Identifying potential sites
- Cost & wait time for interconnection
- Resistance to or covenants banning solar development

Setting a New Target: To 5 Million & Beyond



Solar Energy Innovation Network

The Solar Energy Innovation Network is a collaborative research program that supports multi-stakeholder teams to research and share solutions to real-world challenges associated with solar energy adoption.

APPROACH

- Directly fund teams (up to \$200,000) to work on community-driven innovative ideas
- Technical assistance (TA) and facilitation support to test those innovative ideas
- Peer networking to facilitate participant learning and strengthen outcomes
- TA to enable replication of solutions in other locations

ROUND 3 TOPIC : Equitable Adoption of Solar

- 8 teams working to overcome barriers related to (a) solar and storage for resilience, (b) solar and weatherization and energy efficiency programs, and (c) peer to peer solar outreach and education

Products and tools are available at

<https://www.nrel.gov/solar/solar-energy-innovation-network.html>



**SOLAR ENERGY
INNOVATION
NETWORK**

U.S. DEPARTMENT OF ENERGY



Lawrence Berkeley
National Laboratory



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Access to Solar Financing Overview

Purpose

Across the nation, solar installations have soared for the last 10 years. However, a large number of households, businesses and communities are still unable to access clean affordable power. SETO is working to help ensure all Americans have access to affordable solar energy.

Solar energy can help to reduce energy burden, but only 15% of solar adopters are LMI communities due to barriers in ownership, financing, and information access.

Current Projects

- 11 current projects funded by FY18 and FY19 FOA
- Evaluate alternative solar financing models for low-income consumers
- Develop new tools and methods to better assess credit risk
- Engage community financial institutions and other capital sources to expand solar financing in low-income communities

Geographic Scope

Alternative Financial Models

1	CO	Grid Alternatives
2	TX	Houston Advanced Research Ctr.
3	CO	ICAST
4	CO	NREL
5	MA	Solstice
6	NH	Univ. of New Hampshire

Local Solar Implementation Strategies

7	AZ	Arizona State University
8	VT	Clean Energy State Alliance
9	VA	National Assn. State Energy Officials
10	VA	National Rural Electric Cooperative Assn.
11	DC	Groundswell



Portfolio Overview



Shared solar financing model leveraging Program Related Investments (PRI)



Aggregated shared solar financing model for market rate/unsubsidized MFAH projects



Activating opportunity zones for rapid solar+storage deployment in residential LI communities in Texas



Designing and advancing a new class of financial products envisioned as flexible financial credit agreements (FFCAs)



Research on suitable community solar contract terms for different LMI customer segments and churn and default rates



Create training programs to enable community finance institutions to expand their engagement in solar finance in low-income communities



Developing socially and economically generative, resilient PV-energy systems for LMI communities in Puerto Rico



State strategies to bring solar to LMI communities by researching new solar program designs and associated financing models



Inclusive Shared Solar Initiative (ISSI): leverage LIHEAP, state and local incentives, and other capital funding sources to promote LMI solar.



Achieving cooperative community equitable solar sources for rural electric cooperatives

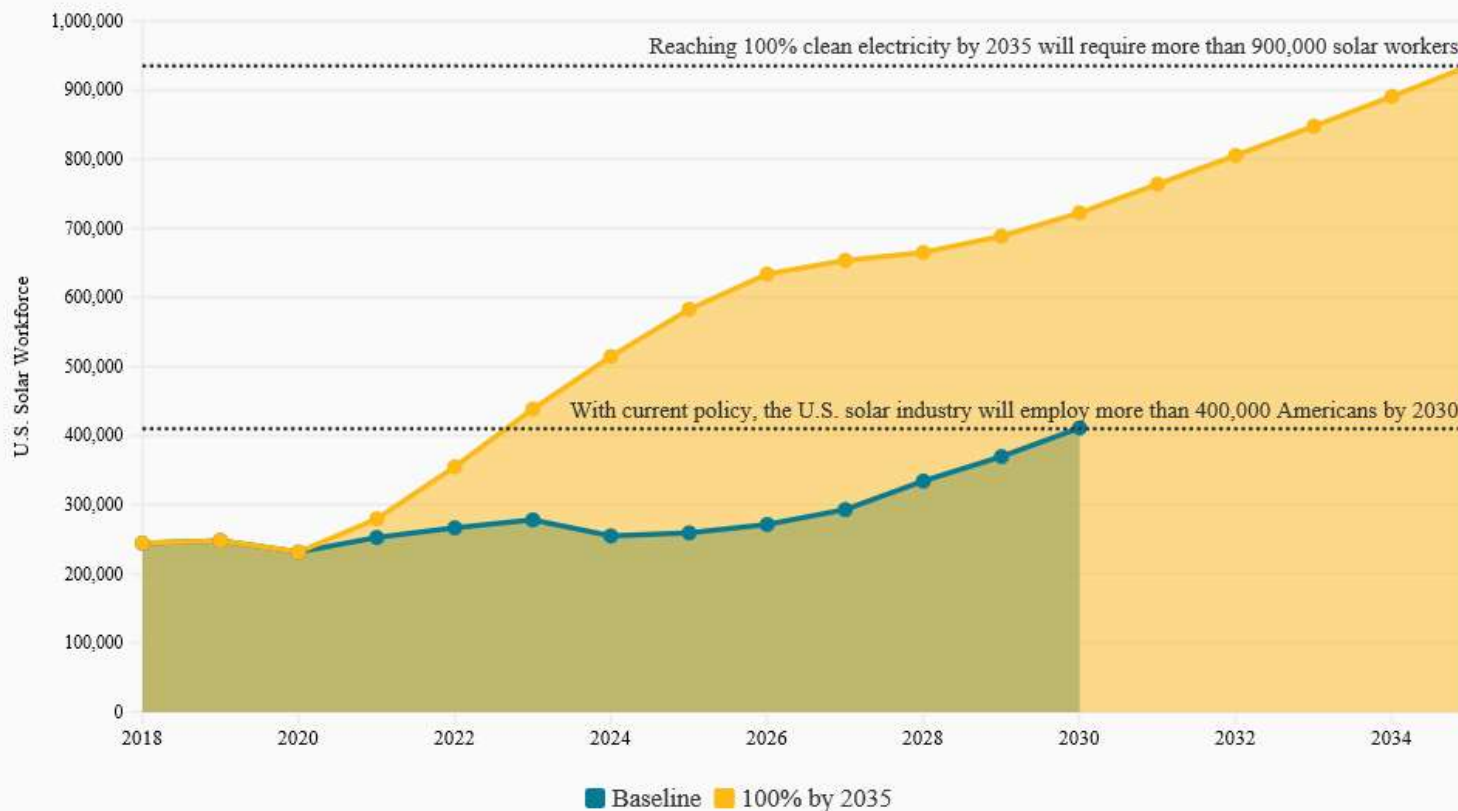


Accelerating Low-Income Financing and Transactions for Solar Access Everywhere

Clean Energy Workforce

Future Workforce Needs

Baseline Solar Employment Forecast vs. Workforce Needed to Reach 100% Clean Electricity by 2035



Source: National Solar Jobs Census 2020, Solar Energy Industries Association, May 2021

Workforce Program Overview

Enable the continued growth of the solar industry by funding workforce development programs, new analysis and outreach efforts, and convening multi-stakeholder and interagency dialogues.



Solar Workforce Development

Solar workforce development includes online training, on-the-job training, curriculum development, and other activities that prepare people for solar.

Current Portfolio

- 8 current awards focused on residential installation
- Solar District Cup
- Training for first responder and building owners
- STEM-focused Fellowship, Post-doc programs

Current Activities

- RFI, stakeholder convenings, and Roundtable
- DOL Collaboration
- NREL Labor Market Analysis
- Future programs focused on multi-stakeholder partnership and advancing equity goals

Workforce Awards

Blue Lake Rancheria

- Native American Tribe in N. CA
- Partners with GRID Alternatives to provide hands-on installation training for NAs
- Capacity building workshops for Tribal Leaders

Safer

- Chicago-based organization focused on returning citizens
- Provides wrap-around training and support to transition Previously Incarcerated Individuals into the solar industry

Midwest Renewable Energy Association

- Partners with 5 local CC to offer NABCEP courses
- Engages with local installers to host student interns to provide on-the-job training

Solar Ready Vets

- The Solar Foundation partners with Hiring Our Heroes to provide corporate fellowships for transitioning military
- Partners with NABCEP and SEIA to build additional capacity for veterans to pursue solar careers

Philadelphia Energy Authority

- Public-private org. promoting clean energy solutions in PA
- Developed a solar program for a vocational high school in Philadelphia
- Partners with Youth Build Philly to provide solar internships for Opportunity Youth

SunSpec Alliance

- DER industry assoc. in CA
- Partners w/ UCSD to develop online training focused on DER cybersecurity and grid integration

Illinois Green Economy Network

- Consortium of 39 CC in IL focused on green careers
- Develop solar curriculum and expand recruitment efforts

Electric Power Research Institute

- Partners with 5 universities to develop new curriculum for grid operations focused on IT, AI, and cybersecurity

Future Workforce Program Priorities

Priorities	Description	Rationale
Industry-driven	Provide training for the jobs & skills the industry needs	<ul style="list-style-type: none"> 57% of solar employers find it “somewhat/very difficult” to find qualified workers Solar installation/project development jobs have increased by 269% over the past 10 years
Employee-centered	Support pathways to family supporting, prevailing wage careers	<ul style="list-style-type: none"> Clean energy jobs already pay higher wages than other jobs requiring comparable education/training Need to focus on transferrable skills and stackable credentials, that prepare individuals for clean energy careers
Diversity, Equity, and Inclusion	Increase diversity in the solar workforce and expand access for under-resourced communities	<ul style="list-style-type: none"> Prioritize the Administration’s EJ goals and the Justice40 Initiative Minority groups, particularly African Americans (8% of the Solar WF, compared to 12% nationally), and woman are under-represented in the solar/clean energy workforce Returning citizens, communities of color, and disadvantaged young people experience higher rates of unemployment and underemployment.

Source: National Solar Jobs Census 2019 and 2020, Solar Energy Industries Association